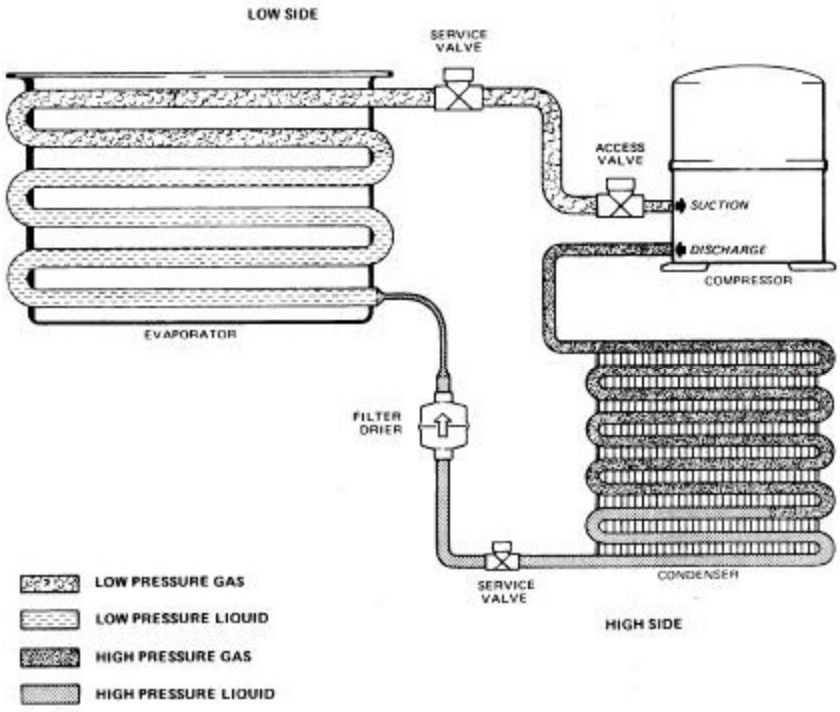
RC-5C *Plus* Refrigeration System:

This section describes the theory and operation of the refrigeration system of the RC-5C *Plus* Centrifuge.

The refrigeration system is a low temperature hermetically seated unit that uses HP-62 (R-404A) refrigerant. The stainless steel evaporator acts as the rotor chamber. Refrigeration control is achieved by cycling the compressor on and off as required.

Refrigeration Cycle:



The refrigerant, HP-62 (R-404A), enters the compressor as a low pressure, heated gas. It is converted into a high pressure, high temperature gas by the compressor and in this state it is pumped to the condenser. A fan circulates cooling air through and around the condenser tubing and heat is released to the atmosphere. As the refrigerant loses heat it becomes a high pressure liquid. The filter/dryer cartridge absorbs foreign particles and water that can enter the subsystem and reduce the refrigeration efficiency. The capillary tube, which controls the low pressure side of the system, restricts the flow of the refrigerant causing a pressure drop across its "length. Refrigerant pressure is high between the output of the compressor and the input to the capillary tube, and low between the output of the capillary tube and the suction part of the compressor. The compressor output side is the high pressure side, the suction side is the low pressure side. Once the required temperature is reached the microcomputer stops the compressor. The refrigeration cycle is started again when the temperature exceeds the required value.

Condensing Assembly Circuit:

The temperature control circuit signals the refrigeration cycle to start by energizing the compressor relay, K101. This solid state 90 amp relay requires an operating voltage of 3 to 30 Vdc, which is controlled by driver amplifier Z2 pin 2.

The logic level command signal, COOLRY (Cool Relay), is used to activate the compressor relay and run the refrigeration system. It originates from the Microcomptuer Board and is sent to the High Voltage Interface Board via J32 pin 7. On the High Voltage Interface Board, the driver amplifier Z2 pin 2 controls the 24 Vdc circuit which drives the compressor relay. It is here that LED DS-3 lights to indicate a response to the COOLRY command signal which is then sent via J101 pin 20 to energize the compressor relay, K101. When energized, the solid state relay allows 230V to be supplied to the compressor and fan.

Temperature Control Circuit:

There are two temperature sensors used in the rotor chamber: one measures chamber air temperature, the other chamber floor temperature. Both sensors are mounted in the floor of the rotor chamber. The air temperature sensor is the most critical and requires calibration. The floor temperature sensor is used only to anticipate rates of temperature change and close calibration is not required.

The sensors are two terminal integrated circuit (IC) temperature transducers that produce an output current proportional to absolute temperature. Utilizing a supply voltage of +12 V, the transducers act as high impedance, constant current regulators. A constant current passes through the transducer and an increasing temperature is detected as an increasing voltage in the circuit.

On the Microcomputer Board the voltages from the transducers are converted to a digital value. This digital temperature value, the digital value of the preset run temperature (as set by the operator using the TEMP °C RUN switches on the front control panel), and the rotor parameters are used mathematically to derive the temperature shown in the TEMP °C display of the front control panel and are analyzed to determine whether or not the COOLRY signal is to be generated to activate the refrigeration system.

The logic level signal SSEL (Z5 pin 19) is used to select one of the two temperature sensors for interrogation. The selection of the sensor to be read is under software control and each sensor is selected for 0.5 seconds. Depending on which logic level is on Z5pin 19, 12 ±1 Vdc are placed on J3-2 (floor sensor) or J3-1 (air sensor). The sensor not interrogated is disabled with 0.2 ± 0.2 Vdc.

An analog to digital (A/D) converter, Z20, is used to convert the analog data (3 sequential 4 BCD bit nibbles) from the temperature sensors to digital data for the microprocessor, Z1. The TEMP signal coming from the selected temperature sensor enters the board at J3 pin 10 and is converted from a constant current

signal to a voltage signal by flowing through 10K resistor R36. Using voltage reference Q2, amplifier Z21 generates a variable reference on pin 14 and can be adjusted by R34. The resulting voltage is then buffered by Z21 pin 7, and fed into the A/D converter input, Z20 pin 11. The data output lines (DO through D3) of Z20 are connected to the low order 4 bits of the data bus (BDO through BD3) thus driving addresses $0220 through $022F. Output lines MSD, LSD, NSD (Most, Least, Next Significant Digit) are connected to the data bus (BD4 through BD6) only during address $022E. The software is programmed to ignore the low order four data bits for all addresses in the $0220 through $022F range, except for $022E. During $022E, 4 BCD bits of data plus identification as Most, Next, or Least Significant Digit, are delivered to the microprocessor. The slower, asynchronous nature of the A/D converter is taken into consideration in the software, which protects against acceptance of erroneous transition data.